SCIENCE, AERONAUTICS, AND TECHNOLOGY APPROPRIATION

LIFE AND MICROGRAVITY SCIENCES & APPLICATIONS

FY 2000 CONGRESSIONAL BUDGET ESTIMATE

SUMMARY OF RESOURCE REQUIREMENTS

	FY 1998 OPLAN 9/29/98	FY 1999 OPLAN 12/22/98	FY 2000 PRES BUDGET	Page Number
		(Thousands of Dollars)		
Advanced Human Support Technology (AHST)	18,088	24,500	29,200	SAT 2-7
[Construction of facilities]	{2,200}			
Biomedical Research & Countermeasures (BR&C)	41,542	59,700	53,000	SAT 2-10
Gravitational Biology and Ecology (GB&E)	28,870	40,900	38,600	SAT 2-13
Microgravity Research (MR)	100,400	113,700	111,400	SAT 2-16
Space Product Development (SPD)	12,900	15,400	14,400	SAT 2-19
Occupational Health Research (OHR)	830	900	1,100	SAT 2-22
Space Medicine Research (SMR)	6,670	6,700	7,100	SAT 2-24
Mission Integration (MI)	4,900	1,700	1,400	SAT 2-27
Total	214,200	263,500	256,200	
Distribution of Program Amount by Installation				
Johnson Space Center (JSC)	55,718	75,800	73,200	
Kennedy Space Center (KSC)	5,330	5,000	3,800	
Marshall Space Flight Center (MSFC)	50,800	65,800	65,500	
Ames Research Center (ARC)	25,000	34,600	32,700	
Langley Research Center (LaRC)	400	200	0	
Glenn Research Center (GRC)	34,800	37,400	38,000	
Goddard Space Flight Center (GSFC)	10,500	9,100	6,100	
Jet Propulsion Laboratory (JPL)	13,200	13,800	14,300	
Headquarters (HQs)	18,452	21,800	22,600	
Total	214,200	263,500	256,200	

GENERAL

The Life and Microgravity Sciences and Applications (LMSA) program is an integral component of NASA's Human Exploration and Development of Space (HEDS) Enterprise. The projects, supported by the LMSA program, through ground - and space-based basic and applied research, seek to advance scientific and commercial knowledge, to enable the development of space for human enterprise, to create new products and services through space research, and to transfer the knowledge and technologies developed as broadly as possible within the United States. We seek to enable and exploit the possibilities of human space flight to improve the quality of life for people on Earth.

PROGRAM GOALS

The Office of Life and Microgravity Sciences and Applications (OLMSA) plays a primary role in the pursuit of the following goals and objectives of HEDS and a secondary role in the pursuit of other HEDS goals. OLMSA provides key products for the following four general goals of the enterprise.

Goal: Explore the role of gravity in physical, chemical, and biological processes

Objective- Enable the research community to use gravity as an experimental variable.

Goal: Continue to open and develop the space frontier

Sub-Goal: Develop and assemble the International Space Station (ISS) and utilize it to advance scientific, exploration, engineering and commercial activities.

Objective - Ensure the health, safety and performance of space flight crews.

Goal: Prepare to conduct human missions of exploration

Objective -- In partnership with the Space Science Enterprise, carry out an integrated program of robotics exploration of the solar system to characterize the potential for human exploration and development.

Goal: Aggressively seek investment from the private sector

Sub-Goal: Increase the affordability of space operations through privatization and commercialization.

Objective - Foster consortia of industry, academia, and government; leverage funding, resources, and expertise to identify and develop space commercial opportunities.

Objective - Share HEDS knowledge, technologies and assets that promise to enhance the quality of life on Earth.

Outcomes:

OLMSA seeks to advance scientific knowledge, to enable the development of space for human enterprise, and to transfer the knowledge and technologies that we develop as broadly as possible. We seek to enable and exploit the possibilities of human space flight and to improve the quality of life for people on Earth. Among the ultimate outcomes of our work are:

expanded fundamental knowledge;
improved health on earth and in space;
improved industrial processes;
expanded commercial activity in space; and
enhanced capabilities for humans to live, work and explore in space.

STRATEGY FOR ACHIEVING GOALS

OLMSA pursues the goals described above through the following projects, which focus on specific fields of research:

Advanced Human Support Technology (AHST)

- Provides cutting edge technologies for the support of humans in space.

Biomedical Research and Countermeasures (BR&C)

- Promotes the health, safety and performance of space crews.
- Investigates the biomedical effects of space flight to provide the biomedical basis for future human exploration and development of space.

Gravitational Biology and Ecology (GB&E)

- Investigates the interaction between gravity and basic biological processes using living systems, ranging from simple cells to humans, in space and on the ground.

Microgravity Research (MR)

- Uses the environment of space to explore the nature of physical, chemical, and biological processes contributing to progress in science and technology on Earth.
- Studies the role of gravity in technological processes, building a scientific foundation for understanding the consequences of gravitational environments beyond Earth's boundaries.

Space Product Development (SPD)

- Facilitates the use of space for commercial products and services.

Within each of these projects, OLMSA supports fundamental and applied research driven by an emphasis on expanding scientific and commercial knowledge and disseminating the research database as widely as possible to the American research and

technology community. Mission driven research improves knowledge and technology for human space flight and exploration; and applications driven research seeks to transfer knowledge, expertise and technology to an appropriate partner or partners.

In addition, OLMSA is an operational organization conducting the following functions:

Space Medicine Research (SMR)

- Provides guidance to the operational medicine community at JSC for the delivery of clinical care in support of human space flight.
- Establishes requirements for medical care and medical research to support human space flight.

Occupational Health Research (OHR)

- Ensures health and safety of all NASA employees.

Mission Integration (MI)

- Integrates research missions involving human space flight.

OLMSA's program of research and technology development relies upon broad participation by researchers from academia, other government agencies and departments, nonprofit and commercial sectors, NASA's Commercial Space Centers (CSCs), NASA Specialized Centers for Research and Technology, and NASA Field Centers. In selecting investigations and projects for support, and ultimately for access to space, OLMSA follows different, but closely related processes for scientific research, for commercial research, and for technology research and development.

Scientific research uses ground-based research to find and refine concepts for space experiments and to create a framework of knowledge and expertise in which the full scientific value of space experiments can be realized. It utilizes the nation's academic and industrial resources, joining prominent researchers with NASA expertise in multidisciplinary microgravity experimentation. In support of the science community, the program also finances unique gravitational simulation facilities such as centrifuges, parabolic aircraft, drop towers/tubes, and other specialized support facilities and technologies such as chambers, bed rest studies, and data archiving. All non-commercial research is conducted on an open, competitive, peer-reviewed research solicitation process including the regular release of NASA Research Announcements (NRAs) in specific disciplines and reviews of proposals by independent panels of experts.

OLMSA implements its space-based research on robotic free-flying vehicles, Space Shuttle missions in which experiments use pressurized carriers (i.e. Spacelab, SpaceHab) and/or unpressurized carriers (i.e., IMPESS pallet, Hitchhiker or Get-Away-Special carriers) that fly in the cargo bay as well as the Shuttle Middeck for small payloads, and, in the future, on the ISS. OLMSA employs this array of flight platforms in support of the broader strategic goals enumerated above. OLMSA does not employ a separate research selection track for mission oriented research. It maintains a queue of worthy research, as opportunities become available.

OLMSA performance targets currently listed within the NASA FY 2000 Annual Performance Plan are as follows:
Goal: Explore the role of gravity in physical, chemical, and biological processes

Objective - Enable the research community to use gravity as an experimental variable

- Support an expanded research program of approximately 935 investigations, an increase of ~ 17% over FY 1999. Publish 100% of science research progress in the annual OLMSA Life Sciences and MR Program Tasks and Bibliographies and make it available on the Internet.
- Using suborbital rockets, complete one combustion experiment on the flame spread of liquid fuels to better control earth/space based fire hazards, and conduct one investigation to test theories of fundamental physics properties and physical laws of fluids to provide key data for earth and space-based processing materials; publish results in peer-reviewed open literature.
- Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with the National Institutes of Health (NIH) in the area of aging and transfer space-derived research for industry development of a new drug to treat Chagas disease.

Goal: Continue to open and develop the space frontier

Objective - Ensure the health, safety and performance of space flight crews

- Develop medical protocols and test the capability of the Crew Health Care System (CHeCS) as integrated in the ISS U. S. Laboratory.
- Evaluate and develop for flight testing a minimum of three major research protocols intended to protect bone, muscle, and physical work capacity and prepare a minimum of 10 biomedical research experiments, utilizing the capabilities of the Space Transportation System (STS) and the ISS Human Research Facility (HRF) to study human responses to the gravitational environment, adding significantly to the general knowledge of these processes on earth.
- Complete the first phase (including outfitting of three test chambers) of the Advanced Life Support System Integrated Test Bed facility which will provide the capability to conduct a series of long duration, human in the loop, advanced technology tests over the next six years. Demonstrate key technology capabilities for human support such as advanced techniques for water processing using microbes, waste processing using biological degradation and fluidized bed incineration, a no-expendable trace gas contaminant control system, solid waste processing, and flight test a miniature mass spectrometer.
- Provide training to the appropriate NASA supervisors with specific emphasis on actions to prevent injury and illness on-the-job. Increase employee participation in the wellness program by at least 25% over the FY 1997 baseline. In coordination with the Office of Safety and Mission Assurance, achieve a 10% reduction in workers compensation claims over the FY 1998 baseline.

Goal: Prepare to conduct human missions of exploration

Objective -- In partnership with the Space Science Enterprise, carry out an integrated program of robotics exploration of the solar system to characterize the potential for human exploration and development

- Complete the Radiation Research Instrument for Mars 2001 mission to study transit, orbital and surface radiation effects and conduct three workshops to define and prioritize research tasks in subjects such as radiation shielding materials, in situ resource utilization and fluids management and heat transfer technology. Complete science definition of granular flows, flight and dust management experiments to begin gathering research data to alleviate critical problems of dust buildup, habitat foundation engineering and rover performance during planetary exploration.

Goal: Aggressively seek investment from the private sector

Sub-Goal: Increase the affordability of space operations through privatization and commercialization

Objective - Foster consortia of industry, academia, and government; leverage funding, resources, and expertise to identify and develop space commercial opportunities

- Utilize at least 30% of Space Shuttle and NASA's ISS FY 2000 capabilities for commercial investigations, per the U.S. Payload Utilization Plan (PUP).
- Establish up to two new Commercial Space Centers (CSCs).
- Foster the establishment of a telemedicine hub in Western Europe. NASA and the French Space Agency (CNES) will develop an international telemedicine program to incorporate and connect existing medical informatics capabilities into a user friendly commercial electronic telemedicine hub and apply lessons learned to human space flight.

Sub-Goal: Share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth

Objective – Involve our Nation's citizens in the adventure of exploring space and transfer knowledge and technologies to enhance the quality of life on Earth

- The NASA sponsored National Space Biomedical Research Institute (NSBRI) will conduct an open symposium relaying the results of space-oriented research activities focusing on up to 10 ground-related applications with the participation of interested investigators; publish results in a conference proceeding report.

BASIS OF FY 2000 FUNDING REQUIREMENT

ADVANCED HUMAN SUPPORT TECHNOLOGY

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Advanced Human Support Technology (AHST)	18,088	24,500	29,200

GOALS

The goals of AHST are: (1) to demonstrate and validate full self-sufficiency in air, water, and food recycling technology for use in space vehicles; (2) to demonstrate and validate integrated, fully autonomous environmental monitoring and control systems; and (3) to validate and incorporate human factors engineering technology and protocols to ensure maintenance of high ground and flight crew skills during long duration missions. AHST makes NASA technologies available to the private sector for Earth applications.

STRATEGY FOR ACHIEVING GOALS

AHST includes Advanced Life Support Systems (ALS), Space Human Factors (SHF), and Advanced Environmental Monitoring and Control (AEMC). ALS develops advanced regenerative life support technologies and systems by combining biological, physical, and chemical processes capable of producing and recycling the food, air, and water needed to enable long-term human missions in space in a safe and reliable manner while minimizing the need for resupply. SHF develops technologies that integrate the human and system elements of space flight and encourages mission planners to use human factors research results and technology developments to improve mission results and crew safety. AEMC develops new technologies, chemical and biological environmental sensors for air and water monitoring and microbial detection, as well as refining and micro miniaturizing currently available sensors.

Center Support

JSC is the lead center for AHST and coordinates all supporting center activities. JSC manages ALS facilities and conducts all system level integration and testing for ALS. KSC manages extramural research and conducts specific research tasks directed at using plants in ALS systems. The JPL is the lead for the AHST AEMC activities bringing their personnel and industry contacts to the development of sensors and monitoring capability. ARC manages extramural research and conducts specific research tasks directed at analytical models and physiochemical processes for ALS systems.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1998. Complete 1998 data will be available in February 1999 with publication of the 1998 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Number of Principal Investigations	40	47	71	70	77
Number of Co-Investigators Supported	80	90	140	138	152
Number of Refereed Publications	40	46	70	69	76

ACCOMPLISHMENTS AND PLANS

During FY 1998, the transfer of program management responsibility, including grants administration, continued from HQs to JSC. Accomplishments include: continued development of solid waste processing technology at ARC; mixed crop evaluations and continued development of the biological processing of solid wastes at KSC; completion of a 91-day, closed-chamber integrated physicochemical/biological life support systems test with four humans at JSC; and initiation of the ALS Systems Integration Test Bed Construction of Facility (CoF) project at JSC. Modification of the existing building foundation was accomplished on-schedule and two of the four Test Bed chamber facilities were delivered and installed. SHF accomplishments include: completion of the rapid prototyping laboratory for advanced displays and controls; completion of three separate SHF related evaluations during the 91-day chamber run; definition of interior architectural layouts for future chamber studies; and gathering of crew interaction data with restraints at glovebox workstations during a shuttle/spacelab flight. AEMC accomplishments include delivery of Electronic Nose for STS-95 flight experiment and the completion of Phase I for Wireless Augmented Reality Prototype (WARP). The Food Technology CSC solicitation was released.

During FY 1999, awards will be made for a new biology-inspired NRA, which includes machine-human interface research. ALS milestones include: continued focused applied research efforts at ARC and KSC; and completion of the ALS Systems Integration Test Bed- facility construction at JSC, including construction and installation of the interconnecting tunnel and airlock for the four chambers and ground support utilities. SHF milestones include the initiation of research projects ranging from communications interactions within the control center to expanded modeling of joints and strength for human application to EVA. Data from the inflight restraint study will be analyzed and results published. AEMC milestones include the successful flight of the Electronic Nose Flight Experiment on STS-95 and the Space Shuttle flight test of a miniature quadrapole mass spectrometer and completion of Phase II for the WARP. The Environmental System CSC solicitation will be released and the Food Technology CSC will be awarded and initiated.

In FY 2000, ALS milestones include completion of the ALS Systems Integration Test Bed design including the major systems buildup for a 30-day “precursor” habitat. SHF focus will be on the performance capabilities of the human with specific emphasis on habitability, on-orbit training, information and design issues and human-system interactions. AEMC will continue to focus on the pursuit of innovative sensor technologies in ground-based technology research and in-flight payload development. The Environmental Systems CSC will be awarded and initiated.

BASIS OF FY 2000 FUNDING REQUIREMENT

BIOMEDICAL RESEARCH AND COUNTERMEASURES

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Biomedical Research and Countermeasures (BR&C)	41,542	59,700	53,000

GOALS

The goals of BR&C are to: (1) reduce risk to crew health from space radiation; (2) reduce risk of acute and chronic health problems, and of psychological and behavioral problems, that increase probability of crew mortality and/or morbidity, decrease crew productivity in flight, or prevent crew resumption of a full, healthy life on Earth; and (3) transfer biomedical knowledge and technology gained through research on the ground and in space to the Earth-based medical community.

STRATEGY FOR ACHIEVING GOALS

BR&C includes research on physiology and behavior, biomedical countermeasures, operational and clinical problems, environmental health, and radiation health. BR&C seeks to characterize and determine the mechanisms of physiological changes in weightlessness, including those that threaten to limit the duration of human space missions. It also develops methods that allow humans to live and work in microgravity, optimize crew safety, well being and performance, and minimize the deleterious effects of returning to earth's gravity after space flight. It attempts to specify, measure, and control spacecraft environments and develop standards and countermeasures, where necessary, to optimize crew health, safety, and productivity. It develops monitoring techniques, procedures, and standards for extended missions. It also seeks to establish the scientific basis for protecting humans engaged in the development and exploration of space from radiation hazards.

Center Support

JSC is the Lead Center for BR&C. As Lead Center, JSC coordinates ARC and KSC supporting center activities. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. ARC supports biomedical research investigations and plays the primary life sciences role in the development of biomedical flight experiments that require non-human subjects. KSC provides pre- and post-flight support for BR&C flight experiments. The NSBRI, a joint cooperative agreement between a seven university consortium led by Baylor College of Medicine and JSC, leads a national effort to accomplish integrated, critical path research in biomedical research and countermeasures development.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1998. Complete 1998 data will be available in February 1999 with publication of the 1998 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Number Principal Investigations	192	153	163	157	185
Number of Co-Investigators Supported	460	275	398	277	325
Number of Publications	290	280	249	285	335

ACCOMPLISHMENTS AND PLANS

During FY1998, the transition of program management responsibility, including grants administration, from HQs to JSC continued. In flight research, 26 experiments comprised the complex, dedicated Neurolab mission (STS-90) that flew on schedule in April 1998. Among firsts, the autonomic nervous system team recorded human sympathetic nerve activity in flight, which may lead to a new understanding of mechanisms underlying orthostatic hypotension. Genomic instability research was jointly funded by the NASA space radiation health project and the National Cancer Institute. An Implementation Memorandum with the Department of Energy established NASA's commitment to support the Booster Applications Facility (BAF) at Brookhaven National Laboratory. This facility is essential for simulating heavy ion space radiation. BR&C completed its research activities on NASA-Mir with the return of the seventh astronaut participant in this project. The project included 44 human life sciences investigations.

During FY1999, BR&C's 23 flight investigations planned for early ISS will begin a rapid development phase to enable their flight in the FY1999-2001 time frame. Also, experiments exploring physiological changes associated with aging were successfully flown on the STS-95 Research Module mission in collaboration with the National Institute on Aging. Experiments will be selected for the STS-107 Research Module mission. An integrated Critical Path Research Plan will be developed to outline a biomedical risk-based mitigation strategy for assuring future successful long-duration human space flights. In FY 1999 NASA will utilize the $6.5M budget increase to fund several space radiation research activities. These activities will expand efforts in cooperation with Loma Linda University and Brookhaven National Laboratory that will take advantage of the Loma Linda proton beam facility and the Brookhaven heavy ion accelerators to simulate space radiation. NSBRI will continue its work on the development of countermeasures, with increased emphasis on collaboration and interaction across physiological disciplines and across institutions.

During FY 2000, BR&C will continue to integrate and augment its efforts towards validating countermeasures produced by the NSBRI, and ground-based research and technology programs. The flight program will increase its utilization of the ISS with the launch of the HRF rack, which enables initiation of complex human physiologic studies on board ISS. In addition, approximately eight BR&C payloads will be carried out on the STS-107 Research Mission. Final preparations will be made for an experiment to

characterize the radiation environment on the surface of Mars as part of the Mars Surveyor program 2001 Orbiter and Lander missions. Space radiation health will intensify international collaboration in the use of high energy heavy ion facilities, cooperation with Loma Linda University, and expand the research community involving, where appropriate, joint support of research efforts by NASA, NIH and other agencies of the Federal government.

BASIS OF FY 2000 FUNDING REQUIREMENT

GRAVITATIONAL BIOLOGY AND ECOLOGY

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Gravitational Biology and Ecology (GB&E)	28,870	40,900	38,600

GOALS

The goals of GB&E are: (1) determine and elucidate the effects of gravity on, and the gravity response of, cellular structures, the genome, cells, physiological systems, organisms and their development, ecosystems, and biological evolution; (2) apply knowledge to support human space flight via countermeasures and bioregenerative life support systems, and further exploration of space via terraforming technologies; and (3) transfer biological knowledge and technology gained through research on the ground and in space to the Earth-based medical and scientific communities.

STRATEGY FOR ACHIEVING GOALS

GB&E seeks to improve understanding of the role of gravity in biological processes by using a variety of gravitational environments as research tools or by determining the combined effects of gravity and other environmental factors on biological systems. It emphasizes research in cell and molecular biology, evolutionary and developmental biology, and organismal and comparative biology. Its research includes plants, animals, or other organisms as subjects, as well as cell or tissue cultures. The disciplines supported are Physical Interactions, Cellular and Molecular Biology, Developmental Biology, Plant and Comparative Biology, Global Monitoring and Disease Prediction, Gravitational Ecology (planned), and Evolutionary Biology (planned). GB&E is also the Lead Center for Life Sciences Outreach.

Center Support

ARC is the Lead Center for GB&E. GB&E also draws upon other centers on occasion to administer tasks or for other unique expertise. KSC provides pre- and post-flight support for GB&E flight experiments. A key collaborative venture between GB&E and the National Institutes of Allergy and Infections Diseases is the use of remote sensing technologies for the prediction and control of global vector-borne human disease such as malaria.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1998. Complete 1998 data will be available in February 1999 with publication of the 1998 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Number of Principal Investigations	88	127	92	153	157
Number of Co-Investigators Supported	90	138	100	175	180
Number of Publications	170	248	190	300	310

ACCOMPLISHMENTS AND PLANS

During FY 1998, the transition of program management responsibility, including grants administration, from HQs to ARC was completed. In flight research, experiments were flown on the Neurolab mission. Preliminary results from Neurolab (STS-90) demonstrated that exposure to microgravity affected early processes in the cellular development of the nervous system. The technical content of GB&E was evaluated and redirected as part of a major restructuring and re-prioritization of goals consistent with the HEDS strategic planning priorities. Ground based research new starts were limited due to funding constraints. Work continued in support of improved global health through the use of space technology. Twelve investigators from a variety of countries including the U.S. came to ARC for a period of several months each to receive training in the application of remote sensing. The goal was to prepare them to use this technology to address human health needs in their respective countries. Investigations were selected to be conducted on the ISS. Proposals for a new Consortium/Center for Research in Evolutionary Biology were solicited and are under evaluation. A collaborative working relationship with the Astrobiology Institute is being developed.

During FY 1999, efforts to restructure and expand the scope of GB&E consistent with the NASA and HEDS strategic plans will continue. New research proposals emphasizing biology-inspired technologies will be awarded. An integrated research activity in evolutionary biology will be developed and investigations selected and awarded. Data from Neurolab flight experiments to define the time course of adaptations in the balance system to alter gravitational environments and to compare the responses of at least three different biological models to understand the influence of gravity on the normal development of the nervous system will be analyzed. Data from research carried out on MIR will be analyzed to achieve a one crew year “jump start” for ISS fundamental biology. Experiments will be selected for the STS-107 Research Module mission. The experiment candidates include research on plants, aquatic specimens, cells, and mice.

During FY 2000, GB&E flight experiments will provide information on the effects of exposure to microgravity on plant growth and development, and information to determine the effects of gravity on plant photosynthesis and respiration. GB&E will commence research in evolutionary biology with participation of at least 5 research institutions. Flight research on the effects of microgravity

on avian development will be carried out. Research proposals on Biological Inspired Technologies will be solicited. Fundamental biology research will be conducted on the STS-107 Research Module mission.

BASIS OF FY 2000 FUNDING REQUIREMENT

MICROGRAVITY RESEARCH

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Microgravity Research (MR)	100,400	113,700	111,400

GOALS

MR seeks to use the microgravity environment of space as a tool to advance knowledge, to use space as a laboratory, to explore the nature of physical phenomena, contributing to progress in science and technology on Earth; and to study the role of gravity in technological processes, building a scientific foundation for understanding the consequences of gravitational environments beyond Earth's boundaries.

STRATEGY FOR ACHIEVING GOALS

The MR strategy for achieving the goals includes sustaining leading-edge research focused in the areas of biotechnology, combustion science, fluid physics, fundamental physics, and materials science that effectively engages the national research community; fostering an interdisciplinary community to promote synergy, creativity and value in carrying out the research. Enable research through the development of an appropriate infrastructure of ground-based facilities, diagnostic capabilities and flight facilities/opportunities and promoting the use of smaller apparatus. Promote the exchange of scientific knowledge and technological advances among academic, governmental and industrial communities and disseminating the results to the general public and to educational institutions. Raising the awareness of the microgravity research community regarding the long-term direction of the HEDS enterprise, and discuss with the community the role of microgravity research in support to agency objectives.

Center Support

MSFC is the Lead Center for MR, drawing upon GRC, JSC, and JPL to administer tasks or for other unique expertise. MSFC provides pre- and post-flight support for MR flight experiments. The National Center for Microgravity Research on Fluids and Combustion, a joint cooperative agreement between the Universities Space Research Association, Case Western Reserve University and GRC, leads a national effort to increase both the number and quality of researchers and to accomplish integrated, critical path research in microgravity fluids and combustion sciences. A new National Center for Microgravity Research in Biotechnology and Materials Science will be formed in FY 2000.

MEASURES OF PERFORMANCE

The actual data reported is based on interim information available as of mid-December 1998. Complete 1998 data will be available in February 1999 with publication of the 1998 OLMSA Life Sciences and MR Program Tasks and Bibliographies annual report.

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Number of Principal Investigations	349	465	344	451	543
Number of Co-Investigators Supported	395	446	395	505	600
Number of Publications	1370	1880	1420	1775	2140

ACCOMPLISHMENTS AND PLANS

During FY 1998, MR conducted broad, productive Earth-based and space-based research. The Fourth United States Microgravity Payload (USMP-4) mission was successfully completed, the final flight of this successful series. Initial results included observation of new physical behavior when matter is confined to only two dimensions during the Confined Helium Experiment (CHeX), which investigated the nature of boundary effects on materials and their properties by examining the superfluid transition of helium. Two studies focused on the process of crystal growth of advanced, "solid-solution" semiconductor materials that serve as infrared detectors. The growth speed and crystal size of a material that serves as a model for industrially useful metals was measured for the first time, without the effects of gravity. Joint American-French research provided the first evidence of certain important crystal growth driving forces in engineering materials whose properties depend strongly on crystallographic direction. Research using NASA's bioreactor was also carried out on the Neurolab mission (STS-90) providing the first information on how microgravity affects the functions of genes from cells. An experiment carried out on STS-89 provided basic understanding of the phenomena that contribute to earthquakes and grain silo explosions. The Solid Surface Combustion Experiment completed its ten-flight long investigation into the laws of burning of solids on STS-91.

MR's activities in the NASA/Mir Science Program were successfully completed. The Mir Glovebox Facility and the Space Acceleration Measurement System (SAMS) were both returned to Earth for inspection after years of deployment and thousand of hours of research use in the Priroda Module, a dress rehearsal for equipment use on the ISS. Research operations in Protein Crystal Growth using the Gaseous Nitrogen Dewar was completed, demonstrating the ability of the new technique to screen a large number of crystal growth conditions at lower cost than on prior shuttle missions. Crystals grown on Mir of Human Immunodeficiency Virus protease inhibitors had better resolution and quality than those grown on Earth, and may assist ground based researchers in defining the structure of the protein(s) which may be important in fighting the AIDS virus. Perhaps even more significant is the large number of trials conducted on Mir growing "model" proteins, to uncover nature's laws that govern the growth of these crystals both on Earth and in space. Analysis of this data will require two years, but may lead to improved crystal growth techniques on Earth as well as more successful growth on the ISS of important proteins related to major diseases.

The first three MR flight investigations for ISS were authorized for full development: Physics of Colloids in Space (PCS), Dynamically Controlled Protein Crystal Growth (DCPCG) and Observable Protein Crystal Growth (OPCGA). The Space Station Furnace Facility was redefined into a more versatile Materials Science Research Facility (MSRF), guided by review of the National Research Councils' National Materials Advisory Board. Redesign of the ISS Fluids and Combustion Facility (FCF) concept was completed as a series of stand-alone 'integrated racks' to accommodate early science within the stretched launch schedule and lowered microgravity research ISS budgets. Full scale mock-ups of the FCF integrated rack concepts were completed and displayed to the user.

Focus on NASA/NIH cooperative activities to transfer the results of MR to the biomedical community continues. Researchers at the NASA/NIH Center for Three-Dimensional Tissue Culture have already produced the first in vitro tissue system which permits the study of HIV pathogeneses inside human lymphoid tissue. In addition, there are currently fifteen ongoing projects at the center addressing a spectrum of biomedical research issues that the NIH identified as having the potential to benefit from the NASA tissue culture technology. To further accelerate NASA bioreactor research on the culturing of human tissues, NASA has renewed this important initiative with the NIH for four additional years. A Foundation for Transplant Research was instituted with VivoRx Corporation using the NASA Bioreactor technology. The Food and Drug Administration worked with NASA to apply microgravity technology on earth to the early detection of cataracts. New, high energy and low cost X-ray technology for space- and Earth-based crystallography was under development by NASA, NIH and industry as a cooperative effort.

In FY 1999, MR will focus on utilization of earth-based facilities for short duration microgravity, preparation of future flight research, two investigations using suborbital rockets and a number of research activities on the STS-107 Research Mission. Research needed to generate low-gravity technology required to advance human exploration of the solar system will be conducted. Definitive conclusion and publication of the results of the Mir Missions will be completed, in particular to provide a three-year advance in techniques for protein crystallization and cell culture research in space. Combustion science, materials science and fluid physics results from the First Microgravity Science Laboratory mission flown in FY 1997 will be published, providing new information on soot formation, the relation of molten material mixing on final solid structure, and colloid crystallization.

In FY 2000, MR will focus on utilization of earth-based facilities for short duration microgravity, preparation of future flight research, two investigations using suborbital rockets and focused research activities on the STS-107 Research Mission. Initial research operations using the ISS will take place. Research needed to generate low-gravity technology required to advance human exploration of the solar system will be expanded. New research projects will be selected in materials science and fluid physics in preparation for the deployment of major and sophisticated research apparatus of those fields on the ISS in FY 2001 and FY 2002. The investigations for early ISS delivered in FY 1999 will be deployed and operated. The ISS FCF and MSRF will complete Critical Design Reviews. Assembly and checkout of the Combustion Integrated Rack and implementation of the detailed design of the Fluids Integrated Rack will be completed.

BASIS OF FY 2000 FUNDING REQUIREMENT

SPACE PRODUCT DEVELOPMENT

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Space Product Development (SPD)	12,900	15,400	14,400

GOALS

The goals of SPD are: (1) to facilitate the use of space for commercial products and services; and (2) to use the unique attributes of space to conduct industry driven research in which materials or knowledge developed in space can be used on Earth for the development or improvement of a commercial product or service.

STRATEGY FOR ACHIEVING GOALS

SPD includes support to the operation of the NASA CSCs, commercial flight research hardware for Shuttle and parabolic aircraft flights, and a limited number of NASA projects in support of commercial objectives. It is a partnership of industry, universities, and local, state, and other federal agencies engaged in commercial space research. SPD encompasses a broad range of NASA efforts to encourage industry participation and investment in space. Commercial space research has the potential to create new or improved products, create jobs, give U.S. industry competitive advantages and improve the quality of life on Earth.

In the 1st Quarter of FY 1999, NASA released the draft Human Exploration and Development of Space (HEDS) Enterprise Commercial Development Plan for the International Space Station. The plan will be refined and begin initial steps towards implementation later in FY 1999.

Center Support

The SPD program is managed for NASA by the MR Program Office at the MSFC. The SPD program is primarily implemented through CSCs. Each CSC is a non-profit consortium of commercial, academic, and/or government entities. The CSCs follow business leads and commitments to pursue product-oriented research in three major disciplines: materials research and development, biotechnology, and agriculture. NASA's role in this partnership is to provide leadership and direction for the integrated program and to provide the flight opportunities that are essential to the success of these efforts.

The CSCs have a unique role in assisting private businesses to conduct space research. They demonstrate to industry the values of space research, and they provide expertise essential to the conduct of successful research in space. CSCs furnish an infrastructure that provides a cost-effective and efficient way for industries to conduct research in space. The CSCs initiate

industry involvement: first, by identifying and investigating research areas of industry-led commercial promise; and, second, by assessing markets for these potential research opportunities. The businesses support the research effort with resources including cash and in-kind such as, technical expertise, research materials, personnel, ground facilities, and research hardware.

MEASURES OF PERFORMANCE

The measures of performance for SPD program capture the number of university and industry affiliates that are working with NASA in the commercialization of space and the amount of funding leveraged from non-NASA sources by the CSCs.

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Industry Affiliates	136	136	198	145	162
University Affiliates	58	58	50	68	80
Payloads Flown	4	4	14	11	12
Non-NASA $M Leveraged	$49.3M	$49.3M	$53.6M	$55.0M	$60.0M

ACCOMPLISHMENTS AND PLANS

During FY 1998, many products enabled by SPD have successfully progressed through various stages of development. Examples include: a new treatment for influenza, developed with the aid of information from space-grown crystals, continues to advance through the drug development and approval process. BioCryst Incorporated, a commercial partner of the Center for Macromolecular Crystallography, has teamed with Johnson and Johnson to develop and market this drug worldwide. Preliminary testing shows the drug to be effective against influenza A and B viruses, and human clinical trials are getting underway.

Proleukin, developed by Chiron Corporation through partnership with BioServe Space Technologies, has been approved by the FDA for use in treatment of bladder cancer and metastatic melanoma. In addition, it is being used in human clinical trials to test its effectiveness as an adjunct treatment for AIDS.

Myotrophin has been submitted by Chiron as a New Drug Application to the FDA for use as a treatment of a neural degenerative disease. The company is also evaluating it as a potential treatment for skeletal disorders, since flight research has demonstrated its effectiveness in preventing the reduction of bone formation that results from space flight.

Chagas disease, a serious health problem in Central and South America is receiving heightened interest through work done by the Center for Macromolecular Crystallography. New studies made possible by the high-quality protein crystals grown on the Shuttle have resulted in significant advances.

Ford Motor Company has used materials data supplied by the Solidification Design Center, a CSC, to design new, high-quality sand molding processes for creating precision automotive parts. This type of work is also being done for ALCOA and Howmet Corporation to help them cast parts that are more reliable with lower production costs.

Brush Wellman Incorporated, successfully produced the world's largest aluminum-beryllium casting with the assistance of ground-based casting data and computational models developed by the Solidification Design Center.

A special optical detector developed by the Space Vacuum Epitaxy Center, a CSC, may offer the hope of sight to people with a variety of eye problems. The detector is designed to be implanted on the back wall of the eye to replace natural sensors damaged by disease or accident. It converts light into electrical signals in much the same way as rods and cones do in a healthy eye, and the impulses are then picked up by the optical nerve. Preliminary testing has been successful and efforts at commercial development are underway.

During FY 1999, SPD will continue near term, precursor research in biotechnology, agriculture and materials processing as well as preparation for flight for commercial investigations planned for the ISS. Research payloads under development include Commercial Instrumentation Technology Association (ITA) Biomedical Experiments, Commercial Protein Crystal Growth and the Microencapsulation Processing System. Materials processing experiments under development range from bone replacement materials to optical fibers. Payloads in development for subsequent ISS flight opportunities include Vulcan hardware, which will be used to collect thermophysical property data of numerous advanced materials that are of interest to industry. The Space Experiments Facility will be flown as part of the first Materials Science Research Rack, collaboration with MR. SPD plans to establish dual-use centers in Food Technology and Environmental Systems, each with a minimum of five affiliates and with contributions at least equal to NASA's contribution. OLMSA will also seek to establish a policy and approach for SPD to sponsor humanitarian international cooperation projects in pharmaceuticals, biotechnology, and medical informatics to contribute to improved health.

During FY 2000, CSCs will continue to be focused on utilization of the ISS for their industry partners, developing and preparing research hardware for flight, and collecting and analyzing results for incorporation into product development activities. A number of commercial research projects using existing flight hardware will be available for flight opportunities. For example, two of the 12 commercial research payloads planned for the STS-107 Research Module mission, involve a project to improve fire suppression using water mists, and a project to produce optical fibers of unprecedented purity. Several product development efforts should reach commercial transition, particularly in the biomedical research area that has used the Commercial Generic Bioprocessing Apparatus and the Commercial Protein Crystal Growth carriers to conduct commercial microgravity research. The Yale informatics center will establish its terrestrial test sites for medical informatics and sensor technologies and will establish a telemedicine hub in Western Europe. SPD will also review and make recommendations on the need for additional CSCs, e.g. for textiles, polymers, photonics, consistent with review group recommendations.

BASIS OF FY 2000 FUNDING REQUIREMENT

OCCUPATIONAL HEALTH RESEARCH

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Occupational Health Research (OHR)	830	900	1,100

GOALS

The goals of OHR are focused on improving NASA's OHR program effectiveness and efficiency through the following programmatic improvements: program standardization and automation; increased inter-center communication; International Organization for Standardization (ISO) compatible programs assessment; technical support center augmentation; and a training program development.

STRATEGY FOR ACHIEVING GOALS

OHR establishes policies and manages implementation of NASA-wide occupational and environmental health activities and services. The OHR function consists of several well-defined constituent activities including Occupational Medicine, Industrial Hygiene, Radiation Health, Physical Fitness, Employee Assistance Programs, Workers' Compensation, Nutrition and Food Safety, and Wellness and Health Education. Collectively, these constituent activities assure the well being and productivity of the NASA work force. OHR has the primary responsibility for the control and elimination of harmful exposures of NASA employees to toxic chemicals and hazardous physical agents, for the prevention of occupational disease and injury, and the promotion of optimal health, performance and productivity. KSC is the Lead Center for OHR.

MEASURES OF PERFORMANCE

Agency Workers' Compensation Rates Plan: 1st Quarter FY 1999	Reduce NASA charge-back billing through the acquisition and implementation of a new case tracking data management system
Early Medical Diagnosis Plan: 4th Qtr, FY 98	Utilization rates of key preventive services such as medical surveillance, employee assistance programs, and fitness centers are indication of positive risk factor interventions aimed at keeping the work-force healthy and productive.

ACCOMPLISHMENTS AND PLANS

During FY 1998, the Occupational Health and Safety Executive Board with a subcommittee on Health, Environmental Management, and Safety held initial meetings to advise on Agency policy in occupational health. Work began on developing web-based training modules on federally mandated occupational health activities. Interagency OHR service agreements were put into place. Evaluation of occupational health management systems for Agency wide use began. Benchmarking of Federal agencies and select Fortune 500 companies' OHR activities was initiated. Agency policy development began for coping with downsizing and other workplace stresses. Department of Veterans Affairs computerized management system for Workers' Compensation claims was instituted. A series of International Public Health Policy seminars, providing professional continuing education credit was conducted comparing health policies and research agendas of seven nations to those of the United States.

During FY 1999, OHR will conduct a series of continuing education ViTS seminars on the Bioethics of practice and broadcast them to the Institute of Biomedical Problems in Moscow, the Commercial Center for Medical Informatics and Technology at Yale, other select academic institutions within the U.S., and all NASA centers. The benchmarking of OHR activities will be expanded to include outstanding private industry organizations, selected through the American Productivity and Quality Control (APQC). A streamlined process verification of Center OHR activities will be implemented. Formal collaborations with the CDC and the American Heart Association will be investigated for potential collaborative use of the HERO database and development of an outcomes-based health Risk Appraisal instrument. An Occupational Health technical support center will be established. An on-line support network of Agency resources on critical occupational health issues will be created. Development of web site training modules for Employee Assistance topics will begin. OHR will also begin evaluation of the possibilities for third party reimbursement of select medical services for partial cost recovery based on data from a pilot study initiated at GRC.

During FY 2000, OHR will evaluate the consolidated contract support for Center OH activities and services. The process to fully automate a health information management system will begin. The Center Process verification program methodology for OHR will be evaluated for effectiveness. Benchmarking results from the APQC will be evaluated for implementation to Center OHR activities. Pursuit of collaborative efforts with the CDC will continue.

BASIS OF FY 2000 FUNDING REQUIREMENT

SPACE MEDICINE RESEARCH

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Space Medicine Research (SMR)	6,670	6,700	7,100

GOALS

The goals of SMR are (1) to ensure the health, safety, and performance of space flight crew members on all U.S. missions: Space Shuttle, the ISS, and the exploration missions; and (2) define and establish the requirements for clinical care and medical research.

STRATEGY FOR ACHIEVING GOALS

SMR has established five inter-related elements: mission support for the Shuttle and ISS Program, astronaut health care, epidemiology (longitudinal studies of astronaut health), Space Medical Monitoring and Countermeasures (SMMaC), and Clinical Care Capability Development (CCCDP). SMR develops the policies and requirements to maintain and provide medical support to optimize the health, safety and productivity of our astronauts in space. It also develops technologies and applications, including telemedicine. SMR provides guidance and oversight of the medical operational support for human space flight and astronaut health care. SMR's scope ranges from the development of astronaut health policies, standards, and requirements for medical operations and medical research as well as the implementation of these requirements through operational medical support for all human space flight programs.

Center Support

JSC is the Lead Center for SMR. JSC manages telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program. Wright State University School of Medicine, Yale University School of Medicine, and the University of Texas Medical Branch at Galveston are the major participating academic institutions.

MEASURES OF PERFORMANCE

Crew Health Care System		Begin on orbit assembly and setup of CHeCS. Develop protocols and test the capability of
Plan:	2nd Qtr 00	the CHeCS as integrated into the ISS.
Actual:	3rd Qtr 99	

ACCOMPLISHMENTS AND PLANS

During FY1998, SMR successfully provided guidance to the operational medicine community at JSC for operational medical support for Shuttle and for NASA-Mir missions, which came to a successful conclusion in the spring. SMMaC completed implementation of Medical Evaluation Requirements (MERs) on NASA-Mir missions that provided new medical and environmental information about long-duration space flight that will help ensure the health and safety of ISS crewmembers. CCCDP was initiated to evaluate and refine space flight medical requirements and procedures and to identify and develop technologies required for the delivery of inflight crew health care. CCCDP activities included successful flight evaluation of the Telemedicine Instrumentation Pack (TIP) on STS-89 and the identification of technology development areas that will be key to delivery of effective medical care during long duration space flight. The Agency Strategic Plan for Telemedicine was implemented through partnerships with the NASA Centers and the CSC for Medical Informatics and Technology (MITA) at Yale University. Transition of management responsibilities to the Yale CSC began for the Internet-based telemedicine test bed, Spacebridge to Russia, as well as interaction with the Space Biomedical Center for Research and Training. Epidemiology continued to examine the incidence of acute and chronic morbidity and mortality among astronauts to better define the medical risks associated with space flight.

During FY1999, SMR will continue to support the needs of the operational medicine community for Shuttle missions and will begin operational medicine support for the ISS with a team dedicated to medical support of the First Increment Crew. ISS CHeCS components will be deployed early in the ISS assembly sequence to provide on-orbit medical, environmental, and countermeasure capabilities for all ISS crewmembers. Medical and environmental information gained from SMMaC will foster refinements in Shuttle and ISS medical systems, protocols, and procedures. CCCDP will continue to support the ongoing evolution of space medicine requirements, procedures, and technologies. Mature telemedicine activities, including the Internet-based telemedicine test bed, Telecollaboration On Line Database (TOLD) (formerly called Spacebridge to Russia) and the Space Biomedical Center for Research and Training will be conducted through the CSC MITA at Yale University. Plans will be developed to augment ISS CHeCS with telemedicine capabilities and other new and emerging medical and environmental technologies. Epidemiology will continue to evaluate the growing body of astronaut health data to better define the medical risks associated with space flight.

During FY 2000, SMR will continue to support the needs of the operational medicine community for Shuttle and ISS missions. Additional ISS CHeCS components will be utilized to provide on-orbit medical, environmental, and countermeasure capabilities for all ISS crew members. In-flight Shuttle and ISS medical capabilities will be augmented with new flight-proven technologies. Medical and environmental information gained from SMMaC will be utilized to refine medical flight system requirements, protocols, and procedures. CCCDP will continue to provide impetus for the evolution of space medicine requirements, procedures, and technologies. Epidemiology will continue to better define the human medical risks associated with space flight and the effectiveness of operational countermeasures in dealing with these risks.

BASIS OF FY 2000 FUNDING REQUIREMENT

MISSION INTEGRATION

	FY 1998	FY 1999	FY 2000
	(Thousands of Dollars)		
Mission Integration (MI)	4,900	1,700	1,400

GOALS

The goals of MI are: (1) provide physical, analytical, and operations integration support to achieve NASA mission objectives for the science and technology communities; and (2) ensure integrated scientific, technological, and commercial user advocacy and coordination of requirements for the next generation of space laboratories, the ISS. These activities include the integration, coordination and policy planning and analysis for International research activities within OLMSA.

STRATEGY FOR ACHIEVING GOALS

In order to meet the function goals and objectives, MI performs the space-based research utilization planning of all OLMSA Space Shuttle and ISS payloads. In addition, through this function, MI carries out systems engineering efforts to develop and evaluate strategies and processes for satisfying current and future research mission objectives. These tasks not only address the current human based space flight platform mission integration processes, but, based on this knowledge base, they define and support new effective and efficient processes and tools for carrying out integrated research advocacy, requirements coordination, mission planning and operations for future space platforms. In particular, the program is investigating ways to apply the engineering and operations lessons learned in the Spacelab program and the NASA/MIR Research Program (NMRP) to the ISS program to achieve greater efficiencies.

Center Support

HQs is the Lead Center for MI. The principal NASA Centers, which conduct activities in support of MI, are JSC, KSC, and MSFC. MSFC provided the analytical integration and operations level project management support for the USMP-4, flown in the first quarter of FY 1998. KSC provided the physical hardware science payload integration project management support for the NASA science payloads USMP-4 flights. In FY 1998, JSC provided the analytical integration and operations level project management support for two NMRP missions (NASA/Mir 8 and NASA/Mir 9), the Neurolab mission and the first of two DOE-sponsored Alpha Magnetic Spectrometer (AMS) flights. KSC provided the physical hardware science payload integration project management support for Neurolab. SpaceHab will provide payload management and integration for research payloads on the STS-95 Research Module mission in FY 1999, and the STS 107 Research Module mission in FY 2001.

MEASURES OF PERFORMANCE

The most significant measure of MI's performance is the provision of an integrated system that ensures successful accomplishment of the science payload objectives on Space Shuttle missions that carry OLMSA sponsored research. Although not directly responsible for the success of a particular experiment, MI is responsible for ensuring that all necessary planning and integration of the collected set of instruments have been comprehensively completed and fully coordinated so that the experimental hardware in concert with flight crew performance and ground control direction have the opportunity to conduct the planned science activities. Science payload objectives vary considerably depending upon the type of mission supported (module missions, pallet/MPESS missions or Space Shuttle Middecks) and the type of scientific investigations performed (microgravity, life sciences, Earth and stellar observations). Depending upon the type of payload, performance is measured in terms of the number of primary missions and the number of Middeck missions successfully flown as scheduled and the successful accomplishment of the science payload objectives:

	FY 1998		FY 1999		FY 2000
	Plan	Actual	Plan	Revised	Plan
Spacelab/SpaceHab/Pallet/Shuttle Attached Missions	3	3	1	1	--
Mir Missions	2	2	--	--	--
Middecks/Small Payloads	6	6	4	4	--

ACCOMPLISHMENTS AND PLANS

In FY 1998, MI provided mission management support to the launch of the USMP-4 and Neurolab missions in addition to two flights to Mir, one of which also flew the first flight of the AMS. Systems engineering efforts continued to support methodologies for advocacy and coordination of U.S. research requirements and implementation of processes and tools for mission planning for U.S. payloads on the ISS. Space Station planning and integration efforts intensified concomitant with the First Element Launch of the ISS. Spacelab-related activities were largely completed in FY 1998, as the Spacelab modules flew for the last time in April 1998.

During FY 1999, MI will provide support for one Shuttle mission: the STS-95 Research Module mission. In addition, MI support will be provided for the second in the series of two research missions (STS-107) to provide a transition between the completed Shuttle missions and onset of significant research capability on-board the ISS. These missions are also intended to be pathfinders for future commercial involvement in carrying out orbital research, and will be implemented through commercially provided carriers and carrier integration services. . In addition, the costs for the mission chargeable to NASA will be supported with a combination of ISS research funding and OLMSA funding.

NASA is developing a plan for a “standby research mission”, involving both new and reflown scientific research, which could be inserted into the shuttle manifest if and when a schedule anomaly occurs. This plan is due to be submitted to the Senate in February 1999.

During FY 2000, MI will continue support for the second DOE sponsored AMS mission planned for the ISS. Space Shuttle “pathfinder” research missions will provide continuing space access to the science and commercial programs until a substantive research capability is available on the ISS in 2002. Support will continue for the STS-107 Research Module mission, scheduled to fly in FY 2001, and fly microgravity, life sciences, and commercial research payloads. This flight opportunity is independent of the ISS Research Program and has been advertised to the ISS partners as opportunities to allow them to begin ISS-type flight experience earlier than planned in the ISS Program. The STS-107 mission will include a double module for accommodating research hardware and will be provided by SpaceHab, Inc. To offset costs, SpaceHab Inc. has been allocated some of the carrier capability to market to non-NASA customers, including ISS partners who wish to take advantage of this research opportunity before they have access to ISS utilization. In return, the costs for the mission chargeable to NASA for its payloads would be offset. This strategy was tested successfully on the first flight, STS-95 and was considered to be a “pathfinder” in terms of the space flight commercialization process.